EASIER TO USE
CONSUMER PCs in 1999
Hardware Implementation Guide

Revision History

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-000.5	Preliminary release of draft for OEM feedback and contribution.	12/18/99
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Table of Contents

Chapter 5 Form Factor

Chapter 6 BIOS

Figures

Tables

Chapter 1
Introduction

This chapter provides an overview of *Designing Easier to Use Consumer PCs in 1999, a Hardware Implementation Guide* (HWIG). Through a broad platform initiative, Intel is promoting greater ease-of-use for the personal computer platform. The initial focus of Chapter 1 is the consumer desktop, which combines usability improvements with exciting new system designs. Utilizing this approach will make the PC more attractive to a much larger consumer audience. Making the PC easier to use provides benefits to the entire industry in the form of additional market opportunities, while significantly reducing the burden of support costs. As with any compelling new feature, those who lead the industry by improving usability will realize product differentiation opportunities.

Focus Areas

HWIG focus areas for *Designing Easier To Use Consumer PCs in 1999* include:

- Simplifying the hardware and software setup, as well as the registration process, including Internet/ISP setup.
- Delivering *Instantly Available* functionality, allowing users to walk up to the PC and quickly access local applications, data, and the Internet.
- Eliminating the ISA bus.
- Accelerating the transition of PC peripherals from “legacy” interfaces (PS/2, game, serial, and parallel ports) to the Universal Serial Bus (USB).
- Enabling PCs that are smaller, sleeker, and quieter.

Implementations span a range of models, including performance and value PC configurations. In particular, many of the easy-to-use platform attributes, which will be fully described, may be added incrementally to all current products. However, to deliver the “Best in Its Class” platform with superior ease-of-use benefits, this architecture will require a new design in all aspects of the platform, as outlined in this guide. The benefits gained and accumulated knowledge from these leadership products can be rapidly integrated into all future product lines.

Scope and Structure

The guidelines in this document apply to the 1999 and 2000 market windows. The primary target is the new Easier To Use PC platform to be introduced in 1999. Some of the information contains previews of requirements for the year 2000.

This guide focuses on the consumer desktop based on the Windows† 98 Second Edition. However, much of the content applies to other consumer and business platforms based on Intel® architecture. When extending the ease-of-use benefits to mobile and workstation platforms, the specific requirements of those segments must be understood. Other companion documents will address these requirements.

This guide is divided into chapters that provide more detailed explanations of the various platform requirements identified in Chapter 2, “Platform Requirements.” Each chapter provides guidelines for particular parts of the PC platform and explains how specific objectives can be met.

Audience

This document is designed for OEMs and their building block suppliers. Suppliers include those providing motherboards, power supplies, peripheral devices, BIOS, operating systems, and other components referenced in this guide.

Intel Reference

Access information on Intel's overall *PC Ease-of-Use* initiative at

Developer.intel.com/technology/easeofuse

Intel's *Instantly Available* initiative is a significant element of making PCs easier to use. Implementation reference material is available at

Developer.intel.com/technology/iapc

Relevant documents include

- *Instantly Available PC Design Guide*
- *Instantly Available PC: System Power Delivery Requirements and Recommendations*

Obtain advance information on specific Intel products and building blocks, such as microprocessors, core logic, and motherboards from the corresponding business units.

Industry Reference

Several industry forums such as PCI, USB, AGP, and DVI have contributed to platform technology advances that improve the user experience. Refer to the appropriate industry forums for these sources.

Obtain reference material covering Form Factor information for motherboards, chassis, and power supplies at

www.teleport.com/~ffsupprt/

This site includes information about the newly introduced *FlexATX* Addendum to the microATX specification.

The *PC 99 System Design Guide* helps promote greater user acceptance, which is the key to attracting new users and potentially expanding market share. Find the *PC 99 System Design Guide* at

Developer.intel.com/design/desguide/

Chapter 2
Platform Requirements

This chapter establishes the platform level requirements and focus areas for a “Best in Its Class,” Easier To Use Consumer PC in 1999.

Specific platform characteristics are identified within the standard PC architecture. These attributes define a first step. Intel will extend the scope of this initiative with continued industry input and focus over time. Systems delivered in 1999 can immediately take advantage of this new direction.

User Expectations

The PC is a complex machine with many subsystems that need to be completely integrated for the user to benefit. Recognizing this, the industry has taken significant steps towards auto configuration of adapters and peripherals, using technologies such as PCI and USB. The consistent use of color-coding and icons also minimizes potential confusion. However, industry data suggests that many people who do note own or use a PC believe that PCs are inherently difficult to set up and use. PCs are not intuitive to operate, and their features can be challenging to configure. When the user modifies a working configuration, the person may have difficulty restoring it to its original state. Generally, the PC is not as easy to set up and use as most consumer electronic devices.

How can these issues be addressed? All vendors with an interest in growing the market for PCs must take responsibility for providing improved solutions, in particular, targeting the first-time user's needs and requirements.

Clear Purchasing Criteria

The experience of buying a PC can be a significant barrier for some users and needs to be addressed. When shipped, the features and capabilities of the PC should be easily identified and conveyed to the user upon delivery. While clear purchasing criteria must be an industry focus, it is beyond the scope of this guide.

Great Out of Box Experience

No assumption can be made regarding the users level of knowledge or experience. For example, higher integration of subsystems is a way of reducing cable requirements, thus improving the users out-of-box experience. Right from the start, PC manufacturers should provide the user with a simple setup process. Typical setup times of an hour or more must be significantly reduced, with minimal demands placed on the user. When problems do arise, help should be easy to obtain. Users today want quick and easy Internet access. Setup operations for online services are also a part of the users experience, and as such, should match applications in ease-of-use.

Intuitive Operation

The personal computer is one of the most powerful, flexible, and necessarily sophisticated devices that the average person will ever use. While power and flexibility are the keys to the PC's success, these same characteristics bewilder many potential new users. The PC should be simple to operate, providing users with spontaneous, intuitive access to information and system functionality. Rather than reduce the PC's flexibility or create an expensive array of single-function computing devices, the challenge is to make executing common tasks simple, fast, and intuitive.

As an area of active research, the man-machine user interface has much room for innovation and evolution. However, many small improvements can provide significant benefits for the first-time user. In particular, this guide recommends that the BIOS functionality and Real-Mode environments be made transparent to the user. It also recommends that frequent operations be made accessible and simple wherever possible. Examples include one-touch *On/Off* buttons, volume control, and indicator lights. If diagnostic capabilities require low-level machine interaction, an alternative mode of operation should support these capabilities.

No Need to Open

PCs should be easy to expand when adding new hardware, software, and networking capabilities. Adding new features should not make PCs less reliable; simple connectivity has real value to new users.

The PC has traditionally provided internal expansion options, including both slots and bays, requiring the user to open the case and confront complex configuration steps. Providing equivalent upgradeability using external Plug and Play buses such as USB offers a significant improvement. This guide recommends using specific external peripherals that may be fully integrated and shipped with the PC.

Fast Boot, Resume and Shutdown

If a PC takes an excessive amount of time to boot or load applications, the user will limit usage to "big" tasks, precluding more spontaneous and frequent use. The user must see the PC as instantaneously available, with a startup experience similar to turning on a TV. This change in perception requires a rapid startup sequence, both from a cold boot and from a suspended machine state. As a result, overhead is minimized at the BIOS and operating system levels. Reduction or elimination of devices should be leveraged to simplify the startup process. Also, the BIOS must perform a silent or quiet boot, suppressing user messages, strings, and prompts.

Likewise, the steps and speed required during shutdown must be made easy and should be similar to that of a TV or VCR. The PC must be capable of suspending the machine's state to RAM and disk, while providing rapid restoration to an operational state.

Always Connected

Today's consumer baseline for data connectivity is the telephone modem. With the availability of cable and DSL (also referred to as *broadband*), the home user can now move beyond short-session modem connectivity to an "always connected" model, similar to LAN connectivity in the workplace. Broadband connectivity enables instantaneous Internet access, without tying up telephone or fax lines. With the "always connected PC," applications can be preprogrammed to apply the PC's "intelligence" as an agent of the user. Examples include downloading e-mail periodically and searching and filtering of web content. Network or incoming "ring" events can wake the PC from a suspended state and provide a programmed response, similar to that of a telephone answering machine.

Improved Ergonomics and Design

A primary challenge is to provide a higher level of integration while making the PC more acceptable for the home environment. The consumer is ready for innovative designs with ergonomic packaging. Particularly, a smaller footprint, improved acoustics, and better accessibility all contribute to improving the experience for the PC user. There is no longer a need for PC design to center on the traditional chassis with the major emphasis on expansion slots and drive bays. The removal of internal expansion leads the way for compact form factors, with many new design innovations already underway.

Integrated Functionality

In the interest of providing improved functionality, this guide recommends that applications be integrated with appropriate user interface and peripheral devices, targeting specific audience needs. Examples include:

- A simple but highly useful application like e-mail that can be automated with a client application that performs a periodic ISP query with a message-waiting LED indicator.
- A “digital dark room” application can be tuned for a true color profile against an integrated scanner or digital camera, monitor, and photo-quality printer.

Product Upkeep

Another major platform requirement, well beyond the scope of this guide, is ensuring that the user has the tools to maintain the machine in the same stable and reliable condition during the entire life cycle. Tools should include both periodic *auto-defrost* and failure/recovery situations, as well as the eventual migration of applications and data to a newer platform.

Benefits to the Industry

To enable continuing market growth and user acceptance while containing support costs, the PC industry must work towards the targets set forth in this guide. The targeted audience for the Easier to Use PC does not currently own a personal computer. Many find the machine too complicated. Others only use a computer at work, where they have a staff and an office infrastructure to support them, but they do not use one at home. The goal of this guide is to target and reduce barriers between this group of potential new users and the benefits of personal computing.

What is the value of this incremental effort to the industry? This approach can re-energize the consumer PC market by offering an exciting, sleek, totally new, and very different type of PC experience. It can grow the market for the consumer PC by catering to the needs of non-users and eliminating the complexity barrier, both real and perceived. Additionally, it may create another vector for OEM product differentiation with the focus on usability. It also has the potential to significantly reduce the support cost burden.

Marking a fundamental change in the industry, this trend offers every OEM an opportunity to lead in the transition.

Attributes - Easier To Use PC

Features presented in this guide should be offered across all consumer segments, providing innovative design, high performance, additional options, and updates that are transparent to install, all within a modest footprint. Except for removing legacy functions, functionality and usage models should be equivalent to, or exceed, the traditional Intel architecture PC platform.

OEMs are encouraged to provide a rich assortment of well-integrated features that benefit from high performance.

Specific features considered essential or desirable in a “Best of Its Class” product for the “Back-To-School 99” retail season are summarized in Table 2-1. Implementation details are described in later chapters of this guide.

Table 2-1. Attributes of the "Easier To Use" PC

Attributes	Essential	Desirable
No ISA slots	X	
ISA resources removed from BIOS setup screen	X	
Replacement of PS/2 keyboard with USB keyboard	X	
Replacement of PS/2 mouse with USB mouse	X	
Integrated graphics, audio, modem, and CD/DVD	X	
Integrated LAN		X
Integrated Home PNA		X
USB connectors in system configuration	4*	
Removal of legacy connectors	Game/MIDI, PS/2	COM, Parallel
Out-of-box physical setup	< 10 minutes	< 5 minutes
First boot and setup, incl. registration, ISP, and SW	< 20 minutes	< 10 minutes
Rapid boot from cold power-up	< 1 minute	< 30 seconds
Rapid resume from S1/S3 suspended state	< 15 seconds	< 10 seconds
Internet connection (resume PC, connect call)	< 45 seconds	< 30 seconds
Turn off PC (shutdown or suspend)	< 15 seconds	< 10 seconds
Add USB peripheral	< 30 seconds	< 15 seconds

continued

Table 2-2. Attributes of the "Easier To Use" PC (continued)

Attributes	Essential	Desirable
Sleek form factor w/small footprint	X	
Low fan noise during normal operation	35dB	30dB
No noise during suspended state	Fan perceived as off	Fully self-cooled
Full recovery capability from CD/DVD image	If no internal floppy drive exists**	
Complete and consistent documentation and software load	X	

* Placement of connectors could be two in back and two in front or some other combination, including external hub devices.

** Removal of the floppy drive is encouraged for smaller form factors, with appropriate attention to boot/recovery requirements.

Evolution of the Platform

The relevant roadmap for the Easier To Use PC trend evolves from very attainable, immediate steps, based on currently available technology. For 1999, the following platform attributes are the focus of this guide:

- Legacy removal, including Real Mode environments, removal of ISA slots, supporting devices, and peripheral I/O connectors
- Adoption of external Plug and Play expansion via USB
- *Instantly Available* technologies, including rapid suspend/resume and silent boot processes and quiet operation
- Slim form factor design

Intel is committed to providing or enabling usability improvements in 2000 and beyond. The company is researching areas where platform design promotes the ease-of-use concept. Reduction in total size and improved diagnostics are expected outcomes of this research.

Intel is also committed to helping the industry establish usability benchmarks that will be correlated with real user experience. To support our customers, Intel can provide these benchmarks and related tools in a checklist format, becoming part of standard system evaluation.

Legacy Removal

With the evolution of the Intel architecture, new approaches to integrating components on the PC platform supercede previous capabilities. When superior functionality can be attained with newer technologies at appropriate cost points, the “legacy” interfaces are ready for obsolescence. An example of an application that has been migrated in this manner is graphics from ISA to PCI and AGP. At some point, older interfaces have no residual functionality and can be removed from the system. This "pruning the tree" is referred to as *legacy removal*.

This guide covers the removal of the following PC legacy interfaces and functions:

- ISA slots
- ISA devices
- Super I/O functions
- External I/O connectors
- Real-Mode environments
- APM BIOS

Desktop Focus

Although the primary environment is assumed to be Windows 98, much of the direction for this guide is applicable to other desktop operating systems hosted on the Intel architecture.

It should be noted that the recommendations in this guide are directed at desktop functionality and cost points. As such, the integration of more expensive mobile subsystems such as mobile CD/DVD drives or Cardbus adapters is specifically not encouraged. For the purpose of discussion, the scope of power management is also limited to the desktop context versus the more aggressive mobile targets.

Chapter 3
Software Considerations

The Easier To Use Consumer PC should run applications designed for Intel-based architecture under popular operating systems such as Windows 98 or Windows 2000.

In this chapter, the configuration of applications and device drivers will be discussed relative to system requirements and various end-user considerations.

Balancing the Bundle

The OEM typically bundles or pre-loads software on the PC so that the consumer can start using their system immediately. PCs shipped without integrated applications are more complicated for the user to set up and use. On the other hand, users typically associate whatever comes bundled with the PC, as something they must understand and be able to use. Considering the diverse levels of skill in the user community, bundled software can often be a source of uncertainty and confusion. The OEM should seek a balance between providing attractive, easy to use features that address the system's primary use, and providing those having relevance to the user.

A selection from the following software categories is commonly targeted for the OEM PC bundle. For example, not every PC is shipped with creativity or educational applications.

- Operating system
- Drivers (including updates)
- Internet applications (including common plug-ins)
- Personal productivity
- Education
- Entertainment
- Creativity
- Work at Home

All bundled applications should be completely pre-loaded. These applications should be immediately usable, requiring a minimal amount of user registration and configuration effort.

User registration should be accomplished through the Internet. Subsequent registration within a product family (e.g., all titles from a particular ISV) should re-use common registration information and ideally, automate the registration process.

All pre-loaded applications should have an uninstall procedure that completely and cleanly removes the application. This procedure should work with the Windows *Add/Remove* programs utility in the Windows Control Panel. In addition, an application's uninstall routine should include functionality that enables the user to recover previously deleted directories.

Configuring for First Boot

The pre-loaded image should be configured in such a way that the first boot is within the target metrics. Recommendations include

- All drivers required for installed devices should be pre-loaded to ensure that no reboots are necessary.
- All USB class drivers should be pre-loaded. A pop-up utility for USB resource management must be enabled and properly configured for dual host-controllers if present.
- All required network drivers should be pre-loaded in order to provide Plug and Play attachment of communication adapters (e.g. LAN, HomePNA, broadband).
- Mouse and navigation tutorials should be readily available for novice users, but designed so that the more experienced user can easily disable them.
- Minimize user registration and software configuration steps.

Internet Software

The Easier To Use Consumer PC configuration includes a core set of Internet applications required to access the Internet:

- Easy ISP selection and configuration
- Browser and e-mail applications that are automatically configured through interaction with the user and ISP registration procedures

The OEM should configure the PC so that initial experiences with the Internet are fast, convenient, and execute within the target metrics. Recommendations include

- Pre-load common browser plug-ins, including those used by customer support.
- Simplify the steps required for the user to locate and launch the e-mail browser and to contact Web-based customer support. Examples of such are desktop icons and keyboard keys.
- Simplify the interactive steps required to access e-mail. An agent mail utility should download incoming mail in the background. One way to accomplished is by dialing up the ISP at night, and triggering a *Message Waiting* indicator, when appropriate.

Enabling Instantly Available

One of the essential attributes of the Easier To Use Consumer PC is fast startup and shutdown, as provided by *Instantly Available* capabilities. The OEM should enable and configure the following attributes:

- Ensure that *resume from S3* state occurs within the specified metrics on USB wakeup or modem ring.
- Enable *Wake on LAN* occurs within the specified metrics if it is supported in the hardware.
- Enable s*uspend to S4* state if it is supported in the BIOS.
- Selectively configure wake-up devices to ensure that the system can drop down to the *S3* state.

Recovery

In the event of problems, the user should be able to easily restore the PC to a known stable configuration. The OEM is responsible for providing an effective backup and recovery mechanism for the user, requiring minimal user intervention. Recommendations include:

- Enable recovery from a “recovery image” on either CD or hard disk. A floppy drive should not be required for recovery.
- The recovery image contents must be identical to the factory pre-load image. This includes all applications and device drivers.
- Enable easy backup and recovery of user files.

The OEM is encouraged to provide recovery options to a last-known working system “snapshot.” The snapshot could be saved using a writable CD-ROM, or at a safe location on the hard disk.

Web-based Service and Updates

The Easier To Use PC must support ways to work on and off the network. Access to standard telephone lines or some type of server is not always reliable or available.

Software updates should appear seamless to the end-user. Web-based updates must focus on installation from the Internet, with the user not necessarily required to download, save, extract, and subsequently run the installation program. The OEM is encouraged to implement a Web-based update mechanism that allows the user to check for updates and schedule reminders.

The computer should also offer the user a means of returning to a last-known working state. The software update model should assist the user in returning to a reliable working environment should any undesirable effects from an application or driver update occur.

Chapter 4
Legacy I/O Removal

The PC interfaces and functions that comprise legacy have been previously described. This chapter discusses the removal of the following legacy components including ISA slots, ISA devices, Super I/O (SIO) functions and I/O connectors.

I/O interfaces have been added incrementally since the early days of the first PCs. The older interfaces no longer support the performance model or functional capabilities required by today's architecture. However, these interfaces are still carried in PC implementations while newer interfaces such as PCI and USB provide superior functionality and performance. The time has come to abandon some of this unnecessary overhead.

Low performance in the I/O subsystem can lead to an unbalanced computer system, to the point where the processing power of the PC cannot be delivered at the optimum platform level. Lack of adequate functional capability, or customized point solutions, make performing some tasks unnecessarily difficult for the user. In some cases, these functional deficiencies can make certain tasks completely impossible.

Rationale for Removal

As examples of legacy I/O inadequacies, consider the following scenarios:

1. The ISA bus is incapable of supporting current generation I/O requirements. This style of I/O has moved from the 8/16 bit ISA to 32/64 bit PCI and AGP buses.
2. The serial port is marginally adequate for conventional fax/modems and does not offer the headroom required by broadband adapters such as Asymmetric Digital Subscriber Lines (ADSL) and Cable modems.
3. Force feedback devices require concurrent, low latency input and output I/O. When legacy I/O connectors are utilized, force feedback is clumsy and ineffective. Also, input, output and power, all require multiple I/O attach points.
4. As a result of applications, which produce much larger data sets, traditional floppy disks can no longer provide adequate backup or file transfer. For example, graphics software used to display and modify video or graphics images, is no longer able to save these images to floppies because of size limitations.

For consumer requirements, alternative interfaces such as PCI, USB, AC-97, AGP and HPNA/LAN provide superior capabilities. This chapter will outline how legacy interfaces are removed from the PC and further identify preferred alternatives for migrating each feature or function.

ISA Slot Removal

ISA expansion slots are no longer required for the PC. Many functions such as audio, LAN and IDE have evolved beyond the limited functionality and bandwidth of the ISA bus. This has been accomplished by moving to other buses and interfaces including PCI, AC-97, and USB. The Super I/O functionality has already been migrated to the LPC bus in anticipation of ISA removal.

How is ISA Removal Accomplished?

The new generation of Intel chipsets implement a new I/O bus called the Low Pin Count (LPC) bus. The Intel 810 chipset is a highly-integrated three-chip solution consisting of a Graphics & Memory Controller (Intel® 82810), an I/O Controller (Intel® 82801), and a Firmware Hub (Intel® 82802). The ISA bus interface is no longer implemented in these chipsets. As a result, by eliminating the associated pins and logic, saving can now be realized in reduced motherboard space. The LPC protocol supports termination of unclaimed ISA cycles with deterministic data returned. The LPC bus supports Super I/O functionality and Flash for the BIOS.

For chipset design information, the OEM should contact Intel's Platform Components Division (PCD) and SIO vendors through their preferred channels.

Migration of Functions from ISA

The following table summarizes how I/O functions formerly located on the ISA bus are implemented in legacy free systems. As noted, many of these functions have already been migrated to other interfaces. For additional information, see Chapter 7, Upgradeability and Peripherals.

Table 4-1. Migration of functions from ISA

Function	Preferred Location
LAN	Already on PCI
Audio CODEC	Already on AC-97, PCI, or Soft Audio
Modem	Migrate to AC-97 AMR or PCI adapter
Graphics	Already on AGP or PCI
Mass Store Controller	Already on Integrated IDE controller or PCI adapter
MIDI / Game Port	Migrate to USB

Benefits ISA Removal

Benefits realized from the removal of the ISA bus:

- There are significant savings in motherboard space, from the removal of both components and connectors. The motherboard form factor can be reduced in size, as described in Chapter 5, “Form Factor.” Additionally, reclaimed board space can be applied towards higher integration of motherboard functions that provide additional ease-of-use benefits.
- The 5, +12, and –12 VDC system power delivery requirements can be reduced when the ISA slots are removed. As an estimate, this translates into a 15W reduction per slot. Actual power savings are proportional to the number of ISA slots removed.
- The –5 VDC rail can be eliminated entirely, since ISA slots are the only system resources that require this voltage.
- By eliminating ISA slots, the chassis size can be significantly reduced. This also allows for more optimal placement of internal peripherals. Chassis size reduction opportunities are described in Chapter 5, “Form Factor.”
- Eliminating ISA slots reduces barriers to airflow. More optimal thermal solutions can be applied, with focus on critical functions such as the CPU, logic, and memory instead of directing air between card slots.
- The BIOS code can be streamlined by removing the ISA Plug and Play associated with non-embedded ISA device discovery, DMA programming, as well as interrupt programming. The size of the BIOS image can be reduced substantially when these legacy Plug and Play features are eliminated.

ISA Options

Using ISA slots is not an option. Embedded ISA devices should be limited to the SIO and Flash.

PS/2 Connector Removal

The PS/2 connectors must also be removed. These are used to support the mouse and keyboard. As replacements, a USB mouse and keyboard should be bundled with the system. The PS/2 keyboard controller (8042) contained in the Super I/O component, must be retained to support existing legacy mode emulation schemes and provide the RC# and A20_GATE signals. During future Super I/O evolution, the functions contained in the 8042 will be migrated into other platform hardware and software.

A USB keyboard and mouse provide full functionality under USB aware operating systems. The USB enabled BIOS utilizes legacy emulation which is required during transition to and from the operating system. . Legacy emulation requirements are covered in the Chapter 6, “BIOS.” Wake on USB keyboard capability has power supply implications that are discussed in the Chapter 5, “Form Factor.”

Benefits PS/2 Removal

The PS/2 ports provide single device connectivity to a keyboard or a mouse, with no other standard functionality. The PS/2 port does not support hot-plug or multiple devices.

USB keyboards and mice have been clearly identified as the preferred HID devices. The Windows 98 operating system supplies native HID class drivers for keyboards and mice. The OEM should determine that the USB keyboard and mouse are HID compliant and that the HID class driver is installed with the loaded image.

In 1999, USB devices should have price parity with PS/2 keyboards and mice based on demand by OEMs. Additionally, many vendors provide keyboards that integrate additional functionality such as a side-port for the mouse, a *Suspend/Resume* button, LED indicators and audio volume control. The OEM is encouraged to deliver higher user value with hot-plug and multi-device attachment capabilities.

Additional USB ports

To augment the USB controller that is part of the Intel chipset, an internal hub component should be integrated on the motherboard or the AMR riser, providing additional ports. It is recommended that a minimum of 2 additional ports be provided. This will require a hub with 3 downstream ports. It is further suggested that at least one of the ports be brought out to the front of the chassis providing easier access for the user.

Alternatively, a second PCI based USB controller may be integrated into the platform. This will double the total available system USB bandwidth from 12 to 24 Mbps. Since USB is the primary I/O expansion for Easier To Use PCs, this additional headroom would allow future functionality to be added, without over subscription of system USB bandwidth.

In order to provide BIOS support for the keyboard and mouse on the second USB controller, the additional controller should utilize the UHCI programming interface provided in Intel's chipsets. Otherwise, keyboard emulation would be limited to the USB ports attached to the chip set controller, a potential source for user confusion.

If the OEM chooses to integrate a USB hub as a bundled external device, this could be an alternative way of providing additional ports. It is recommended that the external hub be self-powered, so that these additional ports support USB devices that may require up to 500mA.

Game/MIDI Port Removal

The Game and MIDI Ports were originally implemented as part of ISA-based sound cards. The Game and MIDI Port functions have now migrated to the SIO, and the audio CODEC has moved from the ISA bus to AC-97.

The MIDI and Game connector must be removed. Additionally, the port registers, and BIOS support may all be removed. However, to maintain compatibility the legacy MIDI and Game port I/O, locations should be considered reserved and not to be used by other system functions.

Game devices and the MIDI adapter are implemented optimally on USB. The OEM should consider integrating USB MIDI and USB Game port controllers with bundled applications.

Benefits Game and MIDI Port Removal

The Game port provides connectivity for a single gaming device, with no other functionality. The Game port does not support hot-plug or daisy chaining. The MIDI Port is used by audio enthusiasts to connect external MIDI adapters and MIDI synthesizers. The limited usage model for MIDI does not justify having a dedicated external I/O port on the PC.

USB gaming devices are identified as the preferred HID devices. The Windows 98 operating system supplies native HID class drivers for game devices. The OEM must ensure that game devices are HID compatible and that the HID class driver is installed in the loaded image.

USB game devices also provide a greater degree of control features and flexibility compared to legacy devices. This is the result of USB being a fully digital interface compared to the traditional legacy analog game port. Furthermore, USB allows definition of more complex control functions than was previously possible with the legacy game port.

USB game devices can be used with games that operate in DOS box mode within Windows 98. There is no longer native mode DOS support for USB. However, since most current generation game applications operate well under Windows 98 with no DOS native mode requirement, USB is being recommended as a viable solution for this portion of new user community.

Serial Port Removal

Traditional PCs have two Serial (COM) port connectors. Historically, COM ports have been used for connecting such devices as serial printers or modems, and for computer-to-computer communication. Equivalent or superior USB implementations of these functions are now available. Additionally, USB-to-COM adapters provide the option of using legacy serial port peripherals.

From the end-user's perspective, COM port connectors should be removed. If the SIO logic remains in the system, the port(s) should be electrically terminated to an inactive state. During normal operation, the BIOS should report no COM ports available.

It should be noted however, that common operating system debuggers require a serial port. A USB to COM adapter cannot be used for this function. Alternative solutions involving hardware and software are under investigation for future use.

To support the current operating system's debugger, the system may provide a COM port on an internal, two row, 0.100" center, 10-pin header. The header signal layout should be such that it allows the use of a 0.50" pitch flat cable assembly with a 10 pin socket connector on one end to mate with the main board header and a standard DB-9 connector (plug type) on the other end. Such assemblies are custom, but widely used today. A suggested board header pin out is given below. In this cable assembly, pin 1 of the header connector must be aligned with pin 1 of the DB-9 connector. Pin 10 must be removed from the main board header, and blocked in the cable connector to ensuring proper alignment during installation.

10 Pin Header for Debugger

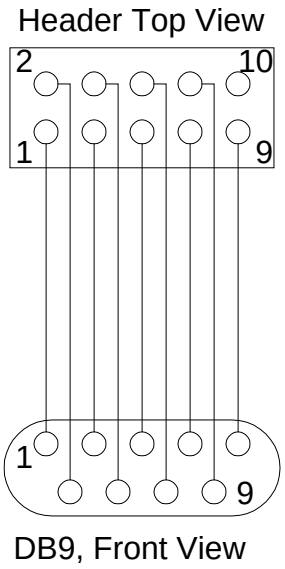

Table 4-2. EIA-232 Signal Assignments

Pin:	1	2	3	4	5	6	7	8	9	10
Header /Cable	CF	CC	BB	CA	BA	CB	CD	CE	AB	KEY
DB9	CF	BB	BA	CD	AB	CC	CA	CB	CE	

During normal operation, the debug COM port must be disabled. The device map produced by the operating system must be consistent with the enabled or disabled state of the COM port.

Parallel Port Removal

The parallel port (LPT) is used for many functions, including printers, scanners, removable storage drives, digital stillcameras, and network connections. However, using the port for more than one device is non-trivial and the cause of much end-user frustration. Equivalent USB peripherals are already available, enabling multiple peripherals to be hot attached and used simultaneously. USB to LPT/Centronics adapters provide the ability to use legacy parallel port peripherals.

All LPT port registers and connectors can be removed. If the SIO logic remains in the system, the port(s) should be electrically terminated to an inactive state. The BIOS should report no LPT ports available. The device map produced by the operating system should indicate the parallel port device as being disabled.

For legacy peripheral compatibility, the OEM may consider providing a USB to LPT/Centronics adapter as an option.

Even if the Parallel Port is retained, bundled peripherals should be USB rather than parallel port versions. The OEM should discourage the user from attaching more than one device to the parallel port, a significant source of configuration problems.

Looking ahead, USB2.0 will allow 10X-20X increased bandwidth. Peripheral vendors should plan their product roadmaps accordingly in order to benefit from this additional capability.

Floppy Removal

The small capacity of the floppy drive (1.44 Mbytes) makes it of limited use as a file backup and transfer mechanism. For these purposes, alternative media such as the Iomega Jazz™ and IMATION SuperDisk™ drive provide improved capacity. Additionally, the SuperDisk can read traditional floppies. An attractive alternative is the writable CD (CD-R and CD-RW). Longer term, write-able DVD will be the only replaceable media required for the Easier To Use PCs. Internal replacement drives should be attached to IDE. External replacement drives should be attached to USB and in the future, to USB2.0.

The floppy drive and interconnect hardware should be removed with the floppy interface signals properly terminated at the SIO. The greatest bill of materials savings can be achieved by using an SIO without a floppy interface. The BIOS should report the floppy as not present to the operating system using standard methods.

Removing the floppy has important implications such as BIOS update and boot block recovery strategy. An internal CD ROM drive must be provided on all systems that provide boot block recovery. A DVD drive satisfies this requirement since it can read a CD-ROM.

BIOS updates can be made using “on-line” downloads to the hard drive or other integrated solutions. The OEM must choose the appropriate model for the distribution of BIOS changes.

BIOS update and recovery routines should be modified to support CD-ROM and both are discussed in Chapter 6, “BIOS.”

Removing the internal floppy drive provides additional space when making platform design tradeoffs and enables smaller chassis solutions. The OEM may consider providing a USB floppy drive as an option. USB to IDE tailgate adapters can also be used, providing acceptable performance for casual storage devices.

Analog Audio

Audio is considered an essential and integral feature of the consumer PC. It is not a user upgrade option.

The long-term goal for this class of Easier To Use PCs is to move all analog sound sources and playback devices to digital interfaces such as USB, having the host processor perform all sound processing and mixing tasks. In the near term, a mix of analog and digital technology will most likely be required to satisfy consumer expectations.

Analog channel control (mixing and volume control), D/A and A/D conversion should be performed by an AC-97 or PCI based CODEC. ISA based sound processors should not be used. The system codec needs to support SoundBlaster™ emulation since the user may wish to run DOS games in a virtual “DOS Box” mode.

The PC should minimally support stereo output and a microphone input. This requirement can be met with analog or USB based components. If greater than two channels of audio output are desired, the system should implement a digital interface such USB or SP/DIF for connection to speaker arrays.

The system speakers should be capable of playing back all audio sources attached to the system. No special purpose speakers, such as the 8254 based beep speaker or a modem speaker, should be implemented. There is no longer a need to support the beep function in the legacy free system. Pre-boot, the bios should not use this function. It is not required post boot since an operating system audio driver will be installed.

The modem audio connection to the system depends on the type of modem used. A controllerless or “soft” modem, does not need an analog connection to the system Codec. It can transmit digitally and receive streams directly to the system audio mixer. “Hardware” or controller based modems, are not typically able to get the digital transmit or receive data to the system. These modems require an analog input to the system Codec and an A/D converter in the Codec to digitize the data. Modem drivers for this type of device need to fully comprehend the volume and mute controls for the phone input channel of the audio codec.

Only post boot, modem speaker support is required. Pre-boot support for modem call progress monitoring is not a requirement for the system.

Analog Video In

Analog video data is relatively new to the PC and no legacy interfaces have been created. However, video imposes stringent performance requirements on platform design. This section describes acceptable strategies when using video capture and display.

Due to the low "attach rate" for this function in the PC at present, analog video capture is typically implemented on a PCI card. In the following discussion, a unified memory architecture (UMA) is assumed

An analog video signal such as composite NTSC is decoded and digitized by capture hardware on the PCI card, with the resulting uncompressed digital signal transferred to memory. An example of a digitized video stream is a YCrCb (4:2:2) stream at 19 MB/s.

The uncompressed data stream can be sent to memory using either the PCI bus or over the AGP bus via a dedicated video side port. An example of a side port interface is the VESA Video Interface Port (VIP Revision 1.1). When compared to PCI, the side port architecture potential provides better "quality of service" for the video data stream. This improved quality of service is the result of the superior bandwidth provided by the AGP bus.

Since the side port is connected to the graphics controller, the side port architecture requires locating the video capture hardware in close proximity to the AGP graphics controller for easy cable routing. If the AGP graphics controller and the capture hardware are both integrated on the system board, no cable is required. In any case, video capture should not be a user upgrade option, due to the cabling complexity when a PCI capture card or an AGP graphics card is used.

Once in memory, the video data can either be re-transmitted to the AGP graphics controller for display, or sent to the system hard drive for storage. *The PC 99 System Design Guide* specification sets the minimum performance criteria of 3.7 MB/s for the storage subsystem. To ensure robust and consistent system behavior, the design should ensure that the sum of compressed video streams and other traffic is within the throughput of the storage subsystem.

If the video data is to be immediately displayed without being saved to disk, no compression is required. It will be sent back across the AGP bus to the graphics controller. It is encoded there for display on a TV or a standard RGB monitor.

TV Out

TV out in the PC is typically provided by a discrete NTSC/PAL encoder that is a part of the graphics subsystem. The following output modes should be supported if TV out is provided:

- Interlaced and non-interlaced
- S Video
- Composite video

The TV monitor and RGB monitor should display the same screen image by default (as shipped). Independent operation of the TV and RGB monitor should require user intervention using the control interface provided by the display utility.

TV out, when provided, should be offered as an integrated feature and as such, should not be a user upgrade option.

Chapter 5
Form Factor

There are significant challenges in designing a highly integrated and more appealing PC for the home environment. The PC desktop is currently built with standard, high-volume building blocks comprised of a chassis, motherboard, a power supply, and internal peripherals. The traditional PC has a recognizable size and shape that is considered acceptable in the office environment. However, in order to meet evolving consumer preferences, the PCs should begin embracing alternative forms, depending on the intended use. Computers are now frequently used in less traditional office environments, including various settings in the home. Manufacturers are experimenting with variations on the current tower design, as well as low-profile desktop PCs. In particular, one relevant trend is towards a smaller, more compact, highly integrated chassis. Small footprint PCs are highly valued in the Asia-Pacific region, and this preference is expected to soon spread to other geographic locations.

Building Blocks

OEMs and System Designers should have a great deal of freedom when defining the shape and size for a computer system. The layout, choice of essential components, and subsystems must provide the design team with maximum flexibility. The building block requirements and options available to the OEMs are the topic of this chapter.

As a general guideline, standardized desktop form factors are preferred wherever possible. They enable the PC OEMs to choose from a variety of motherboards, power supplies, and chassis suppliers that build products based on common industry specifications. Besides reducing the risk associated with new product introduction, designing with standard product parts lowers the overall cost because the components are being produced in huge quantities and are available from multiple sources.

For the User

The concept “Small is Beautiful” definitely applies here! By minimizing the width, length, and height, a small footprint or “slim-and-sleek” design provides many benefits to the user.

From the consumer's perspective, a smaller footprint package allows easy handling and the ability to fit the PC into available desktop or residential space. Higher integration of subsystems also improves the out-of-box experience.

A recent trend is to incorporate the monitor with the computer, or all-in-one packaging built around the LCD or CRT monitor. Innovative and attractive industrial design appeals to the home user.

For the Designer

Easier To Use PCs offers numerous benefits for the OEM and platform designer including:

- Removal of slots and bays provides dimensional freedom in package design.
- Reduction of internal slots and bays streamlines cooling solutions, making the PC acoustically quieter, particularly well suited for residential use.
- Savings from material reduction are transferred to the bottom line.
- With less internal customization, inventory overhead for key components is reduced.
- Manufacturing, packaging, transportation, distribution, and warehousing requirements can be significantly reduced.

Motherboard Form Factor

The industry currently refers to the motherboard layout as a "form factor." The motherboard form factor defines the maximum size of the motherboard, the location of mounting holes, the I/O window, Z-axis keep-out zones, and basic electrical power requirements. Current examples include ATX, microATX, FlexATX and the NLX form factors. Specifications for these form factors are widely available and can be found at the following Form Factor website:

http://www.teleport.com/~ffsupprt/

For small form factor PC designs, the microATX and FlexATX motherboard form factors are recommended. In particular, FlexATX provides the most flexibility for designing highly integrated and innovative system.

Board Dimensions

Table 5-1 provides the dimensions of the ATX, microATX and FlexATX motherboards. FlexATX continues the trend towards a smaller, but backward, compatible motherboard form factors.

Table 5-1. FlexATX, microATX, and ATX Board Dimensions

Form Factor of Board	Maximum Width Allowable	Maximum Depth Allowable
FlexATX	9.00 inches (229 mm)	7.50 inches (191 mm)
microATX	9.60 inches (244 mm)	9.60 inches (244 mm)
ATX, full size	12.00 inches (305 mm)	9.60 inches (244 mm)

Note: All specification references in this chapter are for illustration only. For additional information, the designer should see the latest specification located on the Form Factor website.

microATX

The microATX design is a current, high-volume form factor, which includes motherboard, power supply requirements, and I/O shield aperture. Intel developed this public specification with industry support. The microATX specification is a smaller version of the existing ATX motherboard form factor. It is backward compatible with the ATX specification, using a maximum size of 9.6" x 9.6", and introduces a new set of mounting holes not included in the original ATX specification. With both the ATX and microATX specifications, smaller motherboard sizes can be achieved by eliminating add-in card connectors and integrating additional features directly onto the motherboard.

The microATX motherboard layout and design options are illustrated in Figure 5-1.

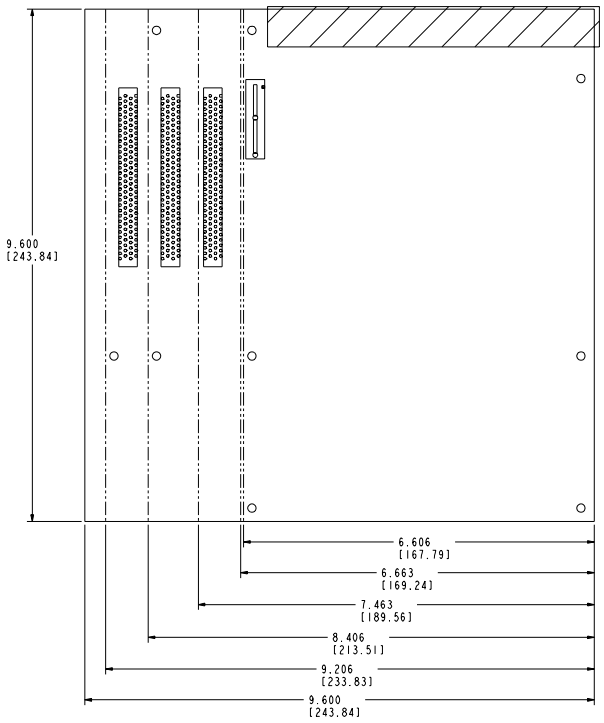

Figure 5-1. microATX Size Reduction Opportunities

The microATX chassis and keep-out zones for subsystem locations are identified in Figure 5-2 and Table 5-2. Motherboard components may not exceed the height limit of each zone defined. This ensures that there is no interference with the chassis structure, power supply, or peripherals. For connectors, the mating cable requirements must be included. Likewise, the power supply, peripherals, and chassis features may not extend into the motherboard component area. Where there are components with heat sinks, the thermal solutions must be engineered within the zone dimensions.

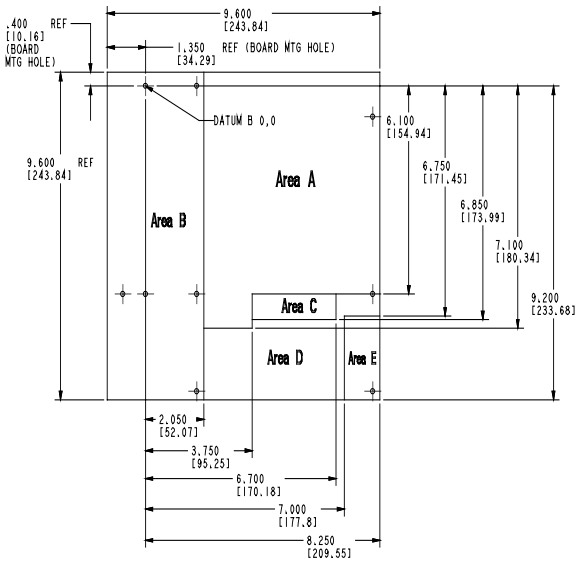

Figure 5-2. microATX Dimensions and Heights

Table 5-2. microATX Area Dimensions Table

Area	Maximum Component Height (in Inches)
A	Motherboard component height, 2.80 inches [71.12mm] maximum
	Chassis clearance over motherboard, 3.00 inches [76.20mm] required
	Chassis clearance over motherboard, 3.50 inches [88.90mm] recommended
B	0.60 inches [15.24mm] (expansion slot area)
C	1.50 inches [38.10mm]
D	1.20 inches [30.48mm]
E	0.35 inches [8.89mm]

FlexATX

The FlexATX form factor evolved from the ATX and microATX form factors. Where microATX is a smaller version of the ATX form factor, FlexATX is optimized for a smaller Z-axis dimension, as well as smaller X- and Y-axis dimensions. It maintains backward-microATX compatibility and supports a 9" x 7.5" motherboard using the same I/O shields. The flexible nature of the FlexATX motherboard specification allows the OEM to utilize the same motherboard for both low profile and space-constrained cases. It can also be used for mini or micro-tower designs.

Designs based on the FlexATX motherboard offer the following benefits:

- Fits in standard chassis, promoting cost savings through economies of scale
- Optimized for removal of legacy adapters and components
- Lower cost than microATX and microNLX
- Allows small footprint customization, including LCD or CRT “all-in-one” integration
- Provides flexible layout options for low-profile components and variable slots

Table 5-3 summarizes the major features and benefits of the FlexATX form factor motherboard.

Table 5-3. FlexATX Feature Summary

Feature	Benefits
9.00" x 7.50" [229 x 191mm] motherboard, maximum size	Smaller size promotes a smaller system size. Smaller size reduces overall system cost.
Standard ATX 2.03 or later I/O panel	I/O shield does not have to be retooled. Motherboard could be used in a microATX 1.0-compliant chassis.
Same motherboard mounting holes as in microATX	Current chassis does not have to be retooled. No need to redefine mounting holes.
Low-profile components	Encourages smaller system designs.

Figure 5-3 and Table 5-3 show a comparison between FlexATX, microATX, and ATX maximum board dimensions.

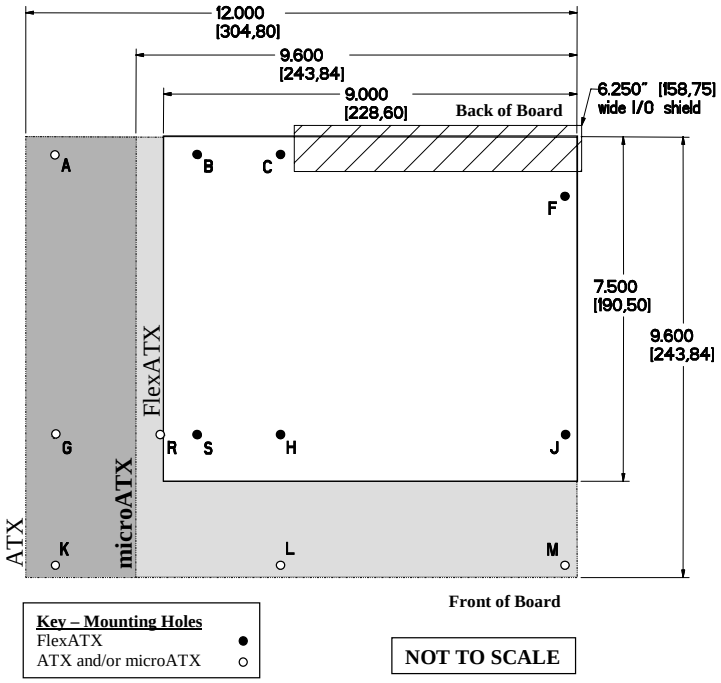

Figure 5-3. FlexATX Layout Options

Note: By using the 4 inside mounting holes, FlexATX designs can reduced down to about 7.5" x 7.5". This enables future designs targeting even smaller form factors.

The FlexATX chassis and keep-out zones for subsystem locations are identified in Figure 5-4. As with the microATX form factor, FlexATX motherboard components may not exceed the height limit of each zone defined.

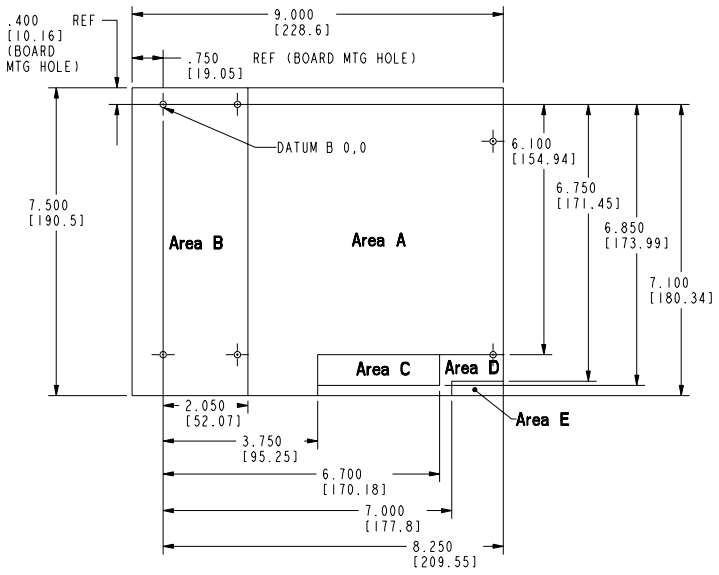

Figure 5-4. FlexATX Dimensions and Heights

Table 5-4. FlexATX Area Dimensions

Area	Maximum Component Height (in Inches)	Status
A	Motherboard component height, 2.10 inches [53.34mm] maximum	Required
	Chassis clearance over motherboard, 2.30 inches [58.42mm]	Required
	Chassis clearance over motherboard, 2.80 inches [71.12mm] Note: There is a 0.20-inch difference between the 2.10-inch required (motherboard maximum component height) and the 2.30-inch required chassis keep-out area.	Recommended
B	0.60 inches [15.24mm] (expansion slot area)	Required
C	1.50 inches [38.10mm]	Required
D	1.20 inches [30.48mm]	Required
E	0.35 inches [8.89mm]	Required

To see the FlexATX addendum, access the Form Factor website. Since this specification is relatively recent, the information in this guide represents work in progress. The reader is encouraged to keep up with proposed improvements.

ATX Riser

One approach to designing low-profile systems with standard form factor components is to use an ATX riser card in slot location 6 of the ATX or microATX motherboard. The riser card provides expandability for 2-3 add-in cards parallel to the motherboard. Figure 5-5 shows an example 3 PCI slot riser card solution with an additional connector extension for extra signals up the riser. This concept will be further described in a white paper to be published on the Web-site in the near future.

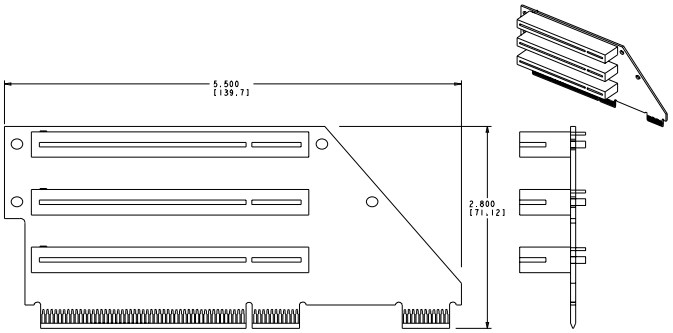

Figure 5-5. Example 3 Slot ATX Riser Card

Low-Profile PCI

As an option, Intel has proposed a Low-profile PCI adapter card that maintains PCI connector compatibility. Figure 5-6 illustrates the proposal to reduce the height of the mounting bracket of standard adapter cards. Low Profile cards offer upgradeability and expandability for ATX and microATX form factors in a low-profile solution without the use of riser cards. The OEMs are encouraged to work with their adapter suppliers when designing for this target. For more information, contact the PCI Special Interest Group.

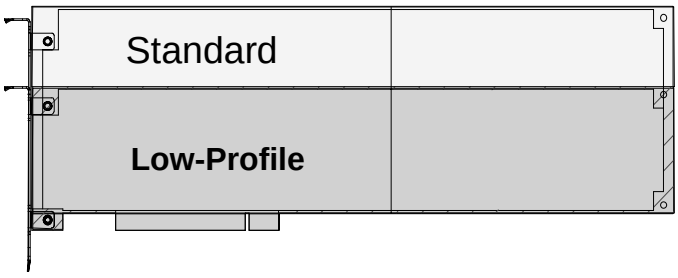

Figure 5-6. Standard PCI and Low-Profile PCI Expansion Card Comparison

Mini-PCI

The PCI industry group is standardizing an alternative adapter form factor based on a the mini-PCI connector and targeted to mobile products. While at a cost premium, this may be an option for small form factor customization and configuration management.

Motherboard Design Considerations

The motherboard chipset that highly integrates the majority of the core logic has a significant impact on motherboard and chassis design. Intel core logic building blocks provide certain benefits, supporting efficient and flexible development of consumer PCs.

For additional details and design collateral, please contact Intel's PCD division through OEM preferred channels.

Motherboard design should take into account optimal placement of the following major subsystems:

- CPU and core logic chipset
- Clock generation circuitry
- Power regulation and dual-mode delivery
- Memory banks, with easy access for user upgrade, if provided
- Graphics, either AGP-based or integrated in the core logic
- Audio
- SIO and Flash
- IDE headers for hard drive and CD-ROM
- AMR header for modem

Chassis Form Factor

The chassis form factor includes additional aspects as a part of the system design:

- Chassis shape, size, and expansion options including access doors and panels
- Location of peripheral bays
- Power delivery, thermal-cooling, and acoustic solutions
- External/internal connector requirements, including positioning and accessibility
- Look of the final product to include color, materials, portability, etc.

Easier To Use PCs should move towards minimizing internal expansion and discourage internal modification by the consumer. Ideally, it should be a sealed PC from the end-user perspective, meaning that all upgrades and expandability should take place externally using a high-speed, Plug and Play interface such as USB. This approach provides a more robust product, minimizing service requirements.

The end user should be able to upgrade PC memory. This should not require that the system be opened beyond accessing a simple side panel for memory upgrades. The design should also include provision for serviceability requirements.

Manufacturers of ATX and microATX chassis can be found at the Form Factor Web-site.

Chassis Z-axis Considerations

The Z-axis dimension refers to the height from the top of the motherboard material to the top of the tallest component, plus recommended thermal and dynamic excursion requirements. This is a primary design consideration for a sleek-and-slim design. The choice and location of internal components should take into account the Z-axis requirements. Critical component selection and placement includes:

- PCI add-in cards
- AMR card
- Power supply
- CD/DVD drive
- Internal speakers
- CPU height, including heat sink and fan
- Stacked I/O
- DIMM/RIMM memory
- Voltage regulator caps

Instantly Available Requirements

The implementation of power delivery and system cooling is considered critical to enabling *Instantly Available* systems. The requirements include

- Dual-mode power delivery that provides headroom for normal operation and auxiliary power during suspend and recovery
- Low acoustics cooling that dynamically scales with ambient and actual dissipation
- Silent operation in suspended state
- Software budgeting of auxiliary power and management of power states across a variable mix of wakeup sources

Power Delivery

The design of power delivery must comprehend the following aspects:

- Elimination of ISA slots, estimated at ~15W per slot
- Reduction or elimination of PCI slots, estimated at 10W per slot
- Auxiliary mode capacity for wakeup devices
- Slim-chassis volumetrics and thermals

Standard motherboard form factors often provide several power supply options. The microATX and FlexATX motherboards include such options, using SFX compatible power supplies, available in many shapes and sizes. These compact units can supply a minimum of 90W which makes it adequate for a slim PC design because power is no longer budgeted for user expansion slots.

A list of power supply manufacturers can be found at the Form Factor website.

The PC power supply must be capable of dual-mode power delivery, with the main supply providing headroom for fully configured continuous operation. The power supply must also feature an auxiliary supply that provides maintenance and resume capacity for the machine suspended state. For details on power specifications, refer to Intel's *Instantly Available PC System Power Delivery Requirements and Recommendations*, Revision 1.0 and *Instantly Available Power Managed Desktop PC Design Guide*, Revision 1.2.

The auxiliary power supply design and power budgeting software must sense the following wakeup devices, subject to actual configuration and expansion options:

- Front-panel *On*/*Off* button device
- USB based *On*/*Off* button device built into keyboard or monitor
- AMR, PCI, or USB-based modem controller
- AMR, PCI, or USB-based G.Lite DSL controller
- PCI-based LAN controller
- PCI- or USB-based HomePNA controller

For 3.3V dual-mode output, the auxiliary capacity of the power supply must meet the following budgetary requirements:

- 100mA for maintaining memory while in the *S3* suspended state
- A maximum additional 375mA of 3.3V dual power per PCI slot that supports remote wakeup
- Additional 20mA of 3.3V dual power for each remaining PCI slot
- Additional capacity for motherboard-integrated wakeup devices

For 5V dual-mode output, the power supply budgeting criteria should include USB wakeup devices and their location within the USB topology to enable ports with the appropriate power budgets. See *USB Interface Power Management Specification* (currently in development). A specific amendment will propose that the maximum device wakeup allowance be reduced from 500mA to 100mA, which is adequate for supporting known wakeup devices.

Note: If a USB wakeup device is connected to a bus powered hub, that is connected to the PC, the PC port will need to adequately budget for the hub requirements in addition to the device requirements. Unused ports will need to budget for device plug-in events while suspended.

It should also be noted that these budgetary estimates are based on a worst case allowance for PCI adapters and USB devices. For most PCI adapters and USB implementations, wakeup requirements are significantly below the maximum allowed. System power budgeting software should be aware of the actual adapter *Suspend* requirements thus ensuring that the *S3* state can be safely reached. By using actual parameters, it is possible to support additional wakeup devices with a smaller auxiliary power delivery capacity than the combined worst case scenario. These numbers are derived from the total number of PCI slots and USB connectors. Power budgeting software must be capable of transitioning the system to the *S1* state should auxiliary supply capacity be exceeded with any given PCI/USB device configuration.

Thermal Design Considerations

The OEM must leverage many important design elements that impact the thermal design. Factors to consider include

- Elimination of ISA slots reduces power dissipation and airflow barriers.
- Elimination or reduction of PCI slots reduces power dissipation and airflow barriers.
- Sleeker chassis design changes the volumetric aspect ratios and clearance over components.
- Choice and location of the power supply and its built-in fan, if present
- Integration of internal peripherals such as CD/DVD and speakers

Low-profile form factors and higher motherboard integration pose new challenges. To complement traditional cooling techniques based on the power supply and CPU fans, it may be necessary to adopt techniques such as heat spreaders, heat pipes, and fan ducts to enable adequate performance headroom. The OEM may also apply thermal monitoring techniques that result in the temporary adjustment of clocks or fan speed proportionate to measured “hot spot” temperatures. Solid design choices permit superior desktop response modulated by the subsystem's thermal time constant.

Acoustic Design Considerations

For the consumer usage model, designing for low acoustic levels is an essential requirement. This consideration includes noise from fans, and peripherals such as disk drives. Noise may be measured in either units of sound pressure (dBA) or sound power (bel). The specifications for these measurements are ISO 7779 and ANSI S12.10. An A-weighted scale replicates the method the human ear perceives noise. Noise produced from personal computers is primarily in the frequency range of 250 Hz to 4KHz. Fan noise is generally below 1 kHz and disk noise is typically above 1 kHz. Using traditional methods, noise pressure is measured at the operator position and must be within the bounds specified under these requirements for both normal operation and in the suspended state. In the future, it is possible that the preferred method for measuring sound will be sound power rather than sound pressure, or some combination of both.

The power supply system fan design must support fine-grained fan speed control using pulse-width modulation or linear control. This design provides thermal monitoring of system “hot spots” and allows for turning up the fan only to the extent necessary. The fan should run very smoothly and with adequate hysterisis. Fan controls that provide only a simple on and off, or do not throttle back and forth, are disruptive in the consumer environment.

The placement of the fan should direct the air outlet away from the user. Additional local cooling may be preferable over using a single fan that provides nominal full-chassis cooling.

To provide the user with the incentive to leave the PC on, it is important to completely turn off all fans when the Easier-to-Use PC is in the *S3* or *S4* state. This implies that all subsystems are designed to be self-cooled in the suspended state.

Integration of Internal Peripherals

Volumetric design of the chassis should include consideration, from the perspective of the user, relative to the location of internal peripherals, including the CD/DVD drive, the AMR riser, and integrated speakers. No specific guidelines are currently provided. This is an area for OEM innovation and differentiation.

Location of I/O Connectors

Industrial design should be viewed, from the perspective of the user, when making decisions on the location of I/O connectors including USB, VGA/DDI, LAN, modem, and audio. By eliminating legacy connectors, there is increased I/O design flexibility. Bringing relevant I/O connectors to the front of the chassis should be considered. No specific guidelines are currently provided. This is another area for OEM innovation and differentiation.

Reliability

The selection of quality subsystems and robust design practices are critical to ensuring life-cycle reliability of 3-5 years, on par with other consumer electronics equipment.

Specific areas of focus include:

- Designing a closed system, with no reason for the user to open the chassis, will ensure against accident-induced failure.
- Adequate thermal headroom will prevent quality deterioration from thermal fatigue.
- Including the use of mechanical buttons, switches, keys, and levers that can be used for repetitive tasks and isolation of environmental dust.
- Adequate plating and tensile strength on connector contacts in order to minimize repetitive removal and cumbersome replacement.
- Ability to withstand static electricity discharge from charged body contact with PC peripherals or chassis.

Manufacturability

Many aspects of this guide impact manufacturability including

- Removal of legacy subsystems that are the basis for existing production test fixtures
- Accessibility to the DOS environment for testing purposes
- Inventory and assembly sequences resulting from new form factors

Serviceability

The system designer is encouraged to ensure that the existing serviceability infrastructure is maximized to the full extent possible. Where justifiable, new, well-conceived and implemented methods and practices may be introduced. However, adequate training of service staff must precede the product introduction to ensure that the end-user experience is significantly improved.

Chapter 6
BIOS

The BIOS is an integral component of the platform and requires special consideration. The following aspects of the BIOS will be addressed:

- Faster system boot, to include minimizing BIOS messages and prompts.
- Minimizing legacy features that are visible to the user, including legacy enumeration.
- Eliminating or simplifying configuration of settings.
- Replace PS/2 keyboard and mouse with USB devices.
- Replacing Replace floppy with CD/DVD for HD recovery.
- Replace floppy with CD/DVD, or HD alternative capability for BIOS recovery.
- Supporting instant wake on event capability.
- Supporting *Suspend/Resume* from *S3* and *S4* states.

This chapter identifies the affected interfaces and recommends the level of BIOS functionality required.

Faster Boot

Developed by Intel, *Instantly Available* specifies low power states that retain adequate system resource to enable a rapid resume of full system operation. Developed by Microsoft, *OnNow* describes a simple interface between the operating system and BIOS limiting unnecessary testing and configuration at boot time.

Improving boot speed information can be obtained by following the recommendations of the *Instantly Available* and *OnNow* initiatives:

http://developer.intel.com/technology/iapc/index.htm

http://www.microsoft.com/hwdev/onnow.htm

Minimum Visible BIOS

The user must not be aware of the BIOS. The machine should be perceived as booting directly into the operating system's user interface without passing through potentially confusing intermediate steps. This progression is referred to as *Quiet Boot* or *Silent Boot* and should result in significant reduction in time the time during the boot process. The metrics recommends specific targets for boot time.

Traditionally, on screen BIOS messages during the BIOS post as well as platform configuration are useful for PC diagnostics. During normal operation these messages should be disabled.

Treatment of Legacy Devices

The traditional BIOS enumerates the platform to locate and enable legacy devices. To the extent that the PC does not contain legacy devices, the BIOS must be hardwired to skip platform enumeration of these functions. Likewise, the BIOS must not attempt to use legacy functions that don't exist. In particular, there should be no emumeration of ISA slots, which will also speed up the post sequence. The Plug and Play BIOS function 40h should return zeros to indicate no ISA bus is present.

Early implementations, using off-the-shelf silicon, are likely to have residual legacy registers present in the decode space, even though the corresponding I/O function is removed from the user's perspective. The BIOS must recognize such resources, but treat them as reserved and inaccessible locations. These resources should also be hardware disabled before control is passed to the operating system. Such resources must not appear as configuration options. Likewise, BIOS services must treat any corresponding hardwired interrupts or DMA channels as unusable and masked.

Configuration Settings

Leveraging the removal of legacy functions, the OEM has the opportunity to do away with the Setup configuration menu. Doing so eliminates end-user complexity without compromising required system functionality. For diagnostic, maintenance, and test support, the Setup configuration options may be retained in CMOS memory and made available through BIOS calls.

If Setup configuration via the standard user console is required, the options must be minimal and user-friendly, requiring no previous experience. The Setup menu should include appropriate recommendations, guidelines and safety nets to prevent disabling the machine or causing a service call.

Enabling detailed diagnostics or changing Setup should require a hardware interlock. Use of keyboard strokes to enter setup or start diagnostics is discouraged due to the fact that there is a high probability of accidental operation. There must also be a way to easily restore default Setup options in case they are corrupted by the user or by an application.

This area has considerable ease-of-use implications and the OEM is encouraged to consider all available options.

USB Keyboard and Mouse

The USB keyboard and USB mouse must be fully supported as primary input devices. The BIOS must enumerate and enable the USB keyboard and mouse as early as possible in the boot sequence. If a USB keyboard and USB mouse are not shipped with the PC, the BIOS should support appropriate variations in USB keyboards and mice, that are consistent with geography or channel requirements and should be fully compliant with supplied documentation.

The USB keyboard or mouse may be located behind USB hubs and should not be directly attached to the PC itself. The BIOS must be capable of enumerating and using the USB keyboard and mouse behind one or more external hubs. The USB keyboard may be an integrated device, incorporating other USB functions such as a trackball, suspend/resume button, audio volume control, etc.

Legacy keyboard and mouse emulation must be supported. This is because transitions to and from the operating system still require the 8042 controller functions. Maintenance and test modes will also require legacy keyboard and mouse emulation if these modes use a legacy Real Mode operating environment.

If a system has more than one USB controller, then both controllers should be UHCI compliant to limit the complexity of the legacy emulation required in the BIOS. If the controllers are different types, then the BIOS must support legacy emulation for both controllers. Although it is not recommended from a consumer ease-of-use perspective, minimally, the system designer may, provide legacy emulation on the ports attached to the UHCI controller. The user on such a system must be explicitly instructed, not to attach the keyboard or mouse to the incorrect USB port when operations demanding legacy keyboard operation are required.

Note: It is not feasible to emulate the keyboard or mouse for a USB port that is located on an add-in card such as PCI. This is because there is no standard way of routing SMI# from the USB host controller on the add-in card, to the motherboard SMI# summing logic. Generating SMI# is required for emulation.

Transitions Requiring 8042 Controller Support

The following non-runtime environments all require 8042 support. 8042 support consists of legacy keyboard and mouse emulation and proper operation of the A20_GATE and RC# signals.

- Operating system installation from the internal CD-ROM drive
- Operating system restart from the shutdown menu
- Real Mode DOS high memory handler
- Operating system “Safe Mode” operation
- Maintenance utilities, such as low level fixed disk formatting, disk image cloning, and processor bios updates.

Legacy Emulation Mechanics

Keyboard and mouse emulation requires the use of the 8042 keyboard controller along with emulation logic. The keyboard controller is usually one function in a "Super I/O" (SIO) multi-function device. Emulation logic is provided by processor chip sets containing USB host controllers and by USB stand-alone host controllers. The emulation logic provides the necessary I/O cycle trapping logic and SMI# generation for emulation.

The 8042 keyboard controller supplies the following, required functions:

- IRQ1 and IRQ12 generation
- Data transfer following an SMI# I/O trap (some BIOS implementations)
- A20_GATE and RC# signals

Other 8042 controller resources, such as unused register bits or Input/Output ports may also be used by a particular BIOS implementation. Because there is no standardization in this area, BIOS developers should move these functions to other hardware resources in the platform such as FLASH, CMOS, and the chip set. This will enable the removal of the 8042 controller in future implementations of the Ease PC.

Boot from a CD or DVD drive

Either a CD or a DVD drive must be integrated internal to the chassis. This device should be supported both as a secondary readable storage device and as a primary boot capable device. The BIOS must support the following CD/DVD functions:

- "El Torito" Bootable CD-ROM Format Specification, Version 1.0. This specification can be found at

  http://www.phoenix.com/products/specs-cdrom.pdf
- Include boot-block secure code for reading a predefined filename and programming the flash
- The flash device(s) selected to contain the BIOS image should have an adequate recovery boot block size (8K bytes or greater recommended) to support BIOS recovery from a CD-ROM. Newer generation symmetrical Flash Memory devices satisfy this requirement.

Boot from a Floppy Drive

If the system integrator decides to leave the floppy drive in the system, this drive should be the primary boot drive when it contains bootable media.

There are significant technical and logistics challenges to overcome if a USB storage device is used as a boot device.

If support is added for booting from a USB drive, then the following functions must be provided by the BIOS – Enumeration and identification of the USB floppy and other removable media devices:

- Deterministic boot device resolution when multiple USB boot devices are found
- Included device driver to enable cold boot from reset
- Included boot-block secure code for reading a predefined filename and programming the flash

USB boot will also negatively impact the boot time. This is because there is no way of detecting whether or not a USB drive actually contains bootable media without spinning up the drive and reading the installed media. Until a method for speeding up external boot on USB is proposed and adopted, this method of boot is not recommended.

Support for Wake on Event

The PC designer is expected to be familiar with *Intel's Design Guide for Instantly Available Power Managed Desktop PC* Revision. 1.2. The PC platform must implement the *S3* state. Support for *S3* allows "Off Yet Communicating" capability for *wake on Ring, Wake on LAN,* and *Wake on USB* events. Wakeup response time must be within the metrics specified.

The BIOS must cooperate with power budgeting software to reconcile auxiliary power supply capacity with the power requirement of wakeup devices that are present. The platform must implement the *S1* state as a safeguard against auxiliary power supply over-subscription by wakeup devices. For details about auxiliary power supply selection, refer to Chapter 5 "Form Factor."

The BIOS should not provide support for alternative legacy power management other than ACPI mode. In particular, timer mechanisms present in hardware but invisible to platform software must never be enabled.

Support for Rapid Resume from Disk

It is highly recommended that the platform implement other power states, including the *S4* state for rapid resume from disk on boot up. While the response time from *S4* is not as spontaneous as the response from the *S3* state, *S4* provides other capabilities that complement the *S3* state.

Similar to *S3*, the user can return from *S4* to the actual state of a prior session, including application and data sets. Using this capability, *S4* can implemented and used as a *backup* of the *S3* RAM image onto disk, in order to failsafe recovery from accidental power removal. The *S4* state can be implemented by the OEM as a user-friendly out-of-box first boot. It may also be useful when the consumer needs to physically relocate the system.

Likewise, support for *S5* allows the system to be shutdown and brought up using the *Soft Off* button.

Chapter 7
Upgradeability and Peripherals

Simplified and flexible upgradeability is a major end-user benefit, allowing the PC to be reconfigured as requirements change. This chapter provides guidelines for applying ease-of-use concepts to both internal and external peripherals. Where relevant, the guidelines are identified as preferred or as an alternative implementation. In general, the preferred implementation places the user closer to a "Best in Its Class" implementation. Table 7-1 provides a summary of the implementations described in this chapter.

Table 7-1. Integration Preferences Summary

Peripherals	Preferred Integration	Alternative Integration
Graphics	AGP on motherboard	AGP adapter
Ethernet/LAN (10/100)	PCI on motherboard	PCI adapter
		USB adapter (10 BASE-T only)
HomePNA Network	USB adapter	PCI adapter
V.90 Modem	Audio-Modem Riser (AMR)	PCI adapter
		USB adapter
ISDN	USB adapter	PCI adapter
Hard Drive	Primary IDE: ATA33 or 66	
CD/DVD Drive	Secondary IDE	
Floppy Drive	USB device	Internal
Hard Audio	PCI component on motherboard	PCI adapter
Soft Audio	AC-97 component on motherboard	
Digital Audio	USB	
Audio I/O jacks	Motherboard analog and S/P DIF	USB adapter for analog and S/P DIF
Speakers	USB integrated into monitor (for tower)	USB subwoofer with side speakers
	Analog integrated in PC chassis (for desktop)	

continued

Table 7-1. Integration Preferences Summary (continued)

Peripherals	Preferred Integration	Alternative Integration
Keyboard	USB device with message-waiting indicator and *Suspend/Resume* button	USB device
Mouse	USB device	
USB Hub	Integrated into monitor	Discrete self-powered device
Game Controllers	USB device	
MIDI I/O	USB adapter	
Desktop Video Camera	USB device	USB integrated in monitor
Video Input	PCI adapter or PCI device on motherboard, connect via VIP 1.1 port-to-graphics adapter	1394 adapter for DV camcorder
Cartridge Drives	USB devices	
Printer	USB device	LAN
Scanner	USB device	
Microphone/ Headphone	USB devices	USB integrated in monitor Analog
G.Lite Modem	PCI adapter	USB communications adapter LAN adapter
Cable Modem	PCI adapter	USB communications adapter LAN adapter
Legacy Adapter (optional)	USB stick with PS/2, COM, Game/MIDI, and Parallel ports	

Internal Peripherals

This guide recommends that the OEMs not provide user-configurable internal expansion options. The following implementation guidelines promote the PC's functionality, simplicity, and performance features within the closed chassis.

AGP Graphics

Graphics should be implemented on the motherboard using either an AGP controller or an integrated chipset. Alternatively, an AGP adapter card may be used, however this approach requires a slot. There must be no provision for user-upgradeable graphics memory. The AGP device must support standard PCI-PM interfaces. Additionally, the graphics controller should support *D1*, *D2*, and *D3* states for quick wakeup. Remote wakeup support is not required.

HomePNA Networking

The HomePNA consumer networking technology allows PCs to be connected over standard home telephone wires, enabling two or more users to productively share an Internet account or use remote PC peripherals such as printers and storage devices. The preferred implementation is on PCI. To provide easy installation, the same RJ-11 telephone connector as that of the internal modem should be used. Installing the networking technology directly on the motherboard may be an option, subject to regulatory requirements. An alternative implementation is using a USB adapter.

HomePNA networking technology is being rapidly adopted in the United States. OEMs may need to address issues specific to other geographical locations as well.

10/100 BASE-T Ethernet

Ethernet is an optional capability. It should be implemented on the motherboard as a PCI component or, alternatively, as a PCI adapter. PCI Ethernet adapters must be power-managed, as discussed in Intel's *Instantly Available PC Design Guide*, Revision 1.2, Chapter 3 and *Network Device Class Power Management Reference Specification*.

If Ethernet is not integrated, the user may obtain this capability with a USB 10 BASE-T adapter.

V.90 or G.Lite ADSL Modem

V.90 modem functionality must be an integrated feature. The V.90 modem can be implemented on an Audio-Modem Riser (AMR) or, alternatively, as a PCI adapter. The AMR is the most cost-effective way to implement a soft V.90 modem. Both AMR and PCI implementations require a slot location. Subject to pending telephony and Data Access Arrangement (DAA) issues, implementing the modem functionality directly on the motherboard may be an option for a model limited to specific countries.

The industry may provide a PCI-based G.Lite modem as a higher performance option. It is recommended that both the V.90 and G.Lite modems share the same RJ-11 connector for ease of installation. Simultaneous operation of the V.90 and G.Lite modems is required. Likewise, if HomePNA is implemented, the modem functions should be simultaneously operable with this networking functionality. If RJ-11 telephone input jacks are provided on the system for user convenience, these jacks must be properly filtered for proper operation with both HomePNA and any broadband modem. The jacks must be clearly marked to prevent the user from making configuration errors. The OEMs may also implement the G.Lite modem as an external USB or Ethernet adapter.

OEMs may also wish to consider designing the PCI modem adapter to manage its own power, as discussed in Intel's *Instantly Available PC Design Guide*, Revision 1.2, (Chapter 3, "Modems"). It must be able to transition between completely "on" *D0* and "off" *D3* Hot states, based on the activity of the communications applications. The PCI adapter must power off the 3.3-Vaux pin in the *D3* cold state, allowing the system to sleep in the *S3* state, while maintaining "wake on ring" capability. Additionally, the modem, while in the *D3* state, must be able to retain caller-ID functionality. If the system is powered down to *S4* state, the *wake on ring* capability is not required.

ISDN Adapter

In some locations, the PSTN network has standardized on ISDN over analog telephony. The ISDN adapter can be either integrated directly on PCI, designed in as a PCI adapter, or provided as a USB option.

Hard Drive

The hard drive must be an ATA33/66 device integrated as the first device on the primary IDE interface. The highest performance mode supported by the drive must be automatically selected by the BIOS. The BIOS must also be capable of auto-configuring the drive media parameters. Any manual configuration options must be limited to the diagnostics mode and should not be visible to the user.

CD/DVD Drive

A CD or DVD drive must be integrated on the secondary IDE interface. The CD/DVD must be the primary boot device for recovery in case of a hard drive failure. It is recommended that the CD/DVD also be capable of restoring the BIOS should the user accidentally erase the PC's hard drive. This boot device capability allows removal of the internal floppy drive. See the next section, "Floppy Drive," as well as Chapter 6, "BIOS" for additional information.

Floppy Drive

The floppy drive is used as a backup device and, optionally, as a recovery/boot device. However, alternative methods can accomplish the limited functionality of the floppy drive.

The floppy backup function may be replaced with USB drives that support the floppy itself and other magnetic or optical media. Various alternative storage devices offer 100-200 MB of capacity on removable cartridges.

The recovery/boot device functionality should be accomplished using the internal CD/DVD device with BIOS support (also see Chapter 6, "BIOS."). Since supporting USB floppy-based recovery/boot device functionality in the BIOS is more difficult than supporting this functionality based on CD/DVD, the OEM should determine whether supporting the former technology is necessary.

By removing the internal floppy drive, the designer saves significant space and has more freedom in chassis design, as discussed in Chapter 5, "Form Factor."

Audio

Soft audio using an AC-97-compliant CODEC on the motherboard is the most cost-effective way to deliver audio with the easier-to-use desktop platform. The motherboard audio function should be implemented as an ACPI-compliant device, with PCI-based audio the preferred method for evolving standards, such as 3D audio. The PCI adapter and driver must support the *D0*, *D3* hot and *D3* cold states. It is not necessary to support remote wakeup.

Analog connections to the platform should be limited to headset, line-in and line-out functionality for consumer electronics devices. If external speakers are supported, digital outputs such as USB or SP/DIF should be provided for connection to the PC.

USB Speakers

To significantly eliminate typical wiring clutter on the desktop, a pair of stereo speakers compliant with the USB Audio Class may be integrated into the USB monitor. Alternatively, analog speakers may be integrated into the PC desktop unit.

For higher-end systems, a USB-driven, self-powered subwoofer with side speakers provides an appealing upgraded solution.

Memory Upgrade

The OEM configuration should include adequate memory for immediate and anticipated usage models. If user-upgrade sockets are provided, these must be easily identifiable and accessible. Preferred access is through a dedicated access door, without the use of special tools.

External USB Peripherals

The USB interface allows for upgrading or adding peripherals outside the PC chassis. The user should not have to open the case when upgrading or adding options. An additional benefit is that USB-based peripheral additions or changes can be accomplished while the system is still powered on and without a reboot cycle. Many categories of USB peripherals are available today at the retail level. Some of the more relevant USB peripherals and bundles will be discussed here, with other recommendations that might be considered at the time of shipment.

USB HID Keyboard

The operating system includes a device class driver for Human Interface Devices, typically referred to as HID. This standard driver eliminates the need for a device-specific driver to be shipped or loaded.

An HID-class compliant, USB keyboard must be shipped with the system. The keyboard’s built-in cable must be long enough for easy connection and use. The supplied cable should be matched to the location of the PC. Its length should be about eight feet for a deskside system and four feet for a desktop system or USB monitor hub. To eliminate user confusion, one of the USB connectors on the chassis or monitor should be marked as suitable for keyboard cable connection.

Optionally, the keyboard design may integrate a USB hub with one or two downstream USB receptacles. If present, the OEM or system designer should identify these receptacles as “low-power” or 100mA in the user documentation because the keyboard will not provide augmented power to the downstream receptacles. Likewise, a low-power USB receptacle is adequate for attaching a USB mouse, which typically draws about 10mA. However, this receptacle is not capable of handing higher power devices such as a USB camera that can draw upward to 500mA. The OEMs should take the necessary steps to minimize user confusion, which may result from keyboard-hub integration.

A system *Suspend*/*Resume* button, or an equivalent HID user interface, should be integrated into the keyboard. The next-generation Intel core logic chipsets support system wakeup from the *S1* or *S3* states based on a USB *Resume* event. The keyboard is also considered an ideal location for a message-waiting indicator light.

USB HID Mouse

A USB mouse that complies with the specifications for HID class devices must be shipped with the system. One of the USB connectors on the chassis, or one of the connectors on either side of the keyboard hub, should be marked as suitable for attaching the mouse. The mouse should be attached to a built-in cable of appropriate length. Suggested length is eight feet long for chassis attachment and about 18 inches for keyboard attachment. The cable should be flexible, and provide smooth, unobstructed mouse movement.

USB HID Monitor

It is recommended that a USB monitor that complies with specifications for HID class devices be also be shipped with each system. This monitor may be either a CRT, or LCD style monitor. The USB monitor must include a USB hub with 3-4 downstream USB receptacles. The monitor must supply full power of 500mA to each downstream port. OEMs are encouraged to provide a HID-based GUI applet for control of monitor display attributes.

The OEM or system designer can also integrate a system *Suspend*/*Resume* button, or equivalent HID user interface, into the monitor as an alternative to integration on the keyboard. Likewise, a message-waiting light can also be integrated into the monitor instead of the keyboard.

The monitor is the preferred device for integrating other USB functions such as speakers, microphone, camera lens, or camera hot-shoe.

USB Video Camera

For video conferencing and single-shot capture, a camera compliant with USB image-class specifications may be bundled optionally with the Easier To Use PC. An integrated monitor-mounting solution, such as a USB hot-shoe, can improve accessibility for the desktop user.

USB Floppy Drive/Cartridge Drive

The complete PC package should include (or be recommend at purchase) a suitable backup device with 100 – 200 MB cartridge capacity. A 1.44 MB USB floppy drive is an option, but is not recommended due to limited functionality. A USB floppy or cartridge drive is not recommended as a recovery/boot device. As an alternative option, an internal CD/DVD drive should be supported as the preferred recovery/boot device.

Other USB Devices

In addition to the core peripherals described above, the OEMs may integrate the PC with one or more of the following optional USB devices and adapters, providing options and improved desktop functionality.

Printer and Scanner

Both the printer and scanner can be simultaneously supported over USB and provide performance superior to that of a parallel port. There are some sheet-feed scanners that can be powered directly from USB.

The OEMs should consider integrating these devices with appropriate photography and still-imaging consumer applications.

Microphone/Headphone

A USB audio-class compatible microphone or headphone can be plugged into a monitor or keyboard hub, providing the user with an easy connection. The OEMs can also supply these devices with built-in, HID-compatible control switches or dials for muting, volume control, and Dictaphone functionality.

The OEMs should consider integrating the microphone with appropriate voice-input applications, such as basic user-interface commands and Internet phone functionality.

Ethernet Adapter

When connecting to another PC or to network services, the PC can be upgraded to 10 Mb LAN capable by using the optional USB-to-Ethernet adapter.

G.Lite ADSL Adapter

With the emergence of USB adapters compliant with the new G.Lite ADSL standard, the V.90 modem functionality can be upgraded for 10-20X Internet throughput and *Always-On* connectivity.

Cable Modem Adapter

With USB cable modem adapters, the V.90 modem can be upgraded for improved Internet access speeds and “always-on” connectivity.

Legacy Recovery Adapter

Multiple vendors are shipping USB-to-legacy adapters of various kinds. The user may maintain compatibility with legacy peripherals by using one of the optional “recovery adapters.” On the other hand, a user requiring legacy compatibility might just prefer to buy a traditional PC that includes legacy functionality.

Note: A USB legacy adapter cannot be used to satisfy all legacy I/O usage models. For example, software debuggers directly access COM port registers and will not use BIOS calls or other hardware access methods which permit re-direction to USB. Real Mode applications that the OEM uses for validation, production test and maintenance may also see this same limitation. Such applications may need to be modified to redirect their accesses via BIOS and Operating System interfaces.